Space Weather Technical Forecast

Issued on Wednesday, 15 November 2023 at 01:18 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Slight chance of G1/Minor Geomagnetic storm day 1 (15 Nov). Decreasing chance of further M-flares.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate, with one M-flare observed, peaking M1.0 at 14/2305 UTC from AR3485. There are four sunspot regions on the disc. AR3485 is close to the southwest limb, and is now difficult to observe. AR3487 also in the southwest, is the largest region on the disc, with some ongoing flux emergence within its intermediate region. AR3486 is another southwest disc spot, however this is a small and simple bipolar region. AR3488 is amongst the plage in the northwest, but is a very small and simple unipolar spot. No Earth-directed CMEs have been observed.

Solar Wind / Geomagnetic Activity: Solar winds, as observed at L1 by ACE and DSCOVR likely showed the passage of a very weak CME from an uncertain source. Wind speeds were slightly elevated at first, rising to peak around 460km/s at 14/0830 UTC before easing to background at 350-400 km/s thereafter. Density was at or just below average. Total magnetic field strength (Bt) was Moderate for much for the period, 10-13nT, but eased to be Weak after 14/2330 UTC. The north-south component (Bz) was initially moderately positive (northward) peaking 13nT, but became generally weakly negative (southward) from 14/1220 UTC, with minimum -8nT. Phi angle was just negative (towards the Sun) at first, but slowly rotated to be more positive (away from the Sun) from 14/1130 UTC. Geomagnetic activity has been Quiet to Unsettled (Kp 0-3).

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux remained at background. GOES16 high energy (greater than 2MeV) electron flux was at background. The associated 24-hour fluence was below the Active (1e8 integrated pfu) threshold. The fluence observation at 15/0000UTC was 2.33e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Generally Low, but with a decreasing chance of rising to Moderate with any isolated M-flares.

Solar Wind / Geomagnetic Activity: Slow CME from the eruption and dimming event on 10 Nov has the potential to give a glancing interaction on day 1 (15 Nov), however this is low confidence and any enhancement is currently expected to be limited. A further slight enhancement is likely days 1-2 (15-16 Nov) from a connection to the fast wind of small CH70/-, with speeds potentially reaching 450 km/s, easing day 3 (17 Nov) onward. Mainly Quiet geomagnetic activity at first, rising to Unsettled to Active later day 1 and into day 2 (15-16 Nov). Any combined effect of the CME and coronal hole HSS will bring a slight chance of an isolated G1/Minor geomagnetic storm. Activity easing to be Quiet with isolated Unsettled intervals day 3 onward (17 Nov).

Energetic Particles / Solar Radiation: GOES16 High energy proton flux is expected to remain at background. GOES16 High energy electron flux is likely to rise through the period as any elevated electron populations at lower orbits relax back towards GEO. This is low confidence

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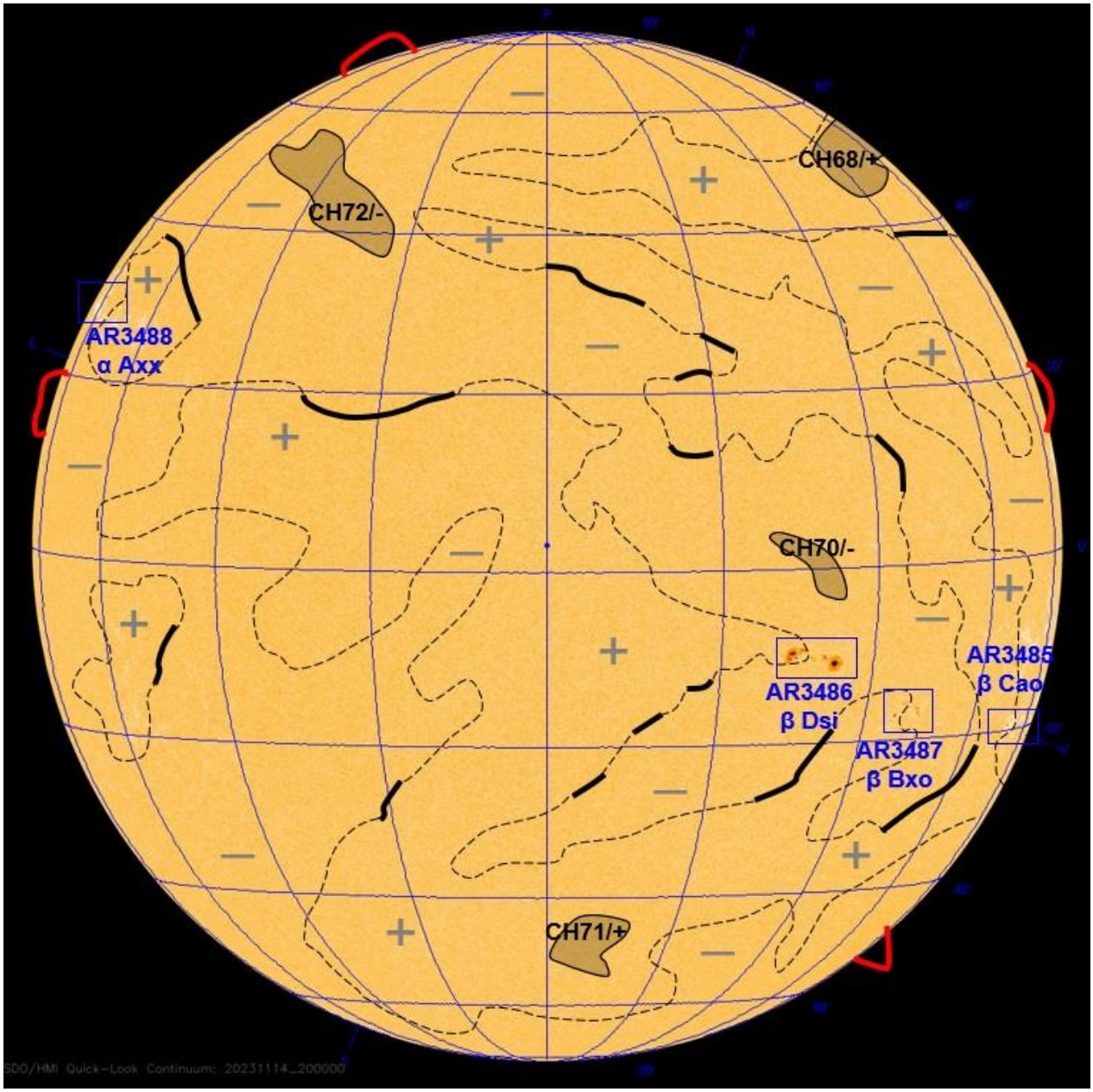
however, especially with the potential for further weak enhancements to the solar wind on day 1 15 Nov). The associated electron fluence is likely to remain below the Active threshold (1e8 integrated pfu) but with an increasing slight chance of rising above.

Figure 1. Solar Analysis Valid 14/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A slow CME was observed on 10 Nov resulting from a weak eruption between AR3484 and AR3485 on the southwest quadrant, along with associated coronal dimming. This has been modelled a just ahead (west) and south of Earth, but with a glancing impact possible day 1 (15 Nov). Any impact is likely to be minimal however, with the CME indistinct in imagery and travelling at a similar speed to the background slow wind, which is currently at around 350km/s.

A further potential enhancement is possible however, due to the small central disc coronal hole CH70/-. This is expected to give a period of slightly enhanced solar winds, to around 400-450km/s, with onset most likely later on day 1 or day 2 (15-16 Nov), before quickly easing to background day 3 onward (17 Nov). This is slightly later than current MOSWOC Enlil expectations, which is considered too early with the onset of any CH70 HSS.

Mainly Quiet geomagnetic activity at first, rising to Unsettled to Active later day 1 and into day 2 (15-16 Nov) from either the fast wind enhancement, or any glancing interaction from the CME. Any combined effect will bring a slight chance of an isolated G1 Minor Storm. Activity easing to mainly Quiet day 3 onward (17 Nov).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	15	5	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
11/0633	Nil	Filament	SW	378 km/s	15/1200 +/- 12hrs	Low confidence. Glancing impact.

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Figure 2a: Enlil and ensemble showing weak CH and CME arrival

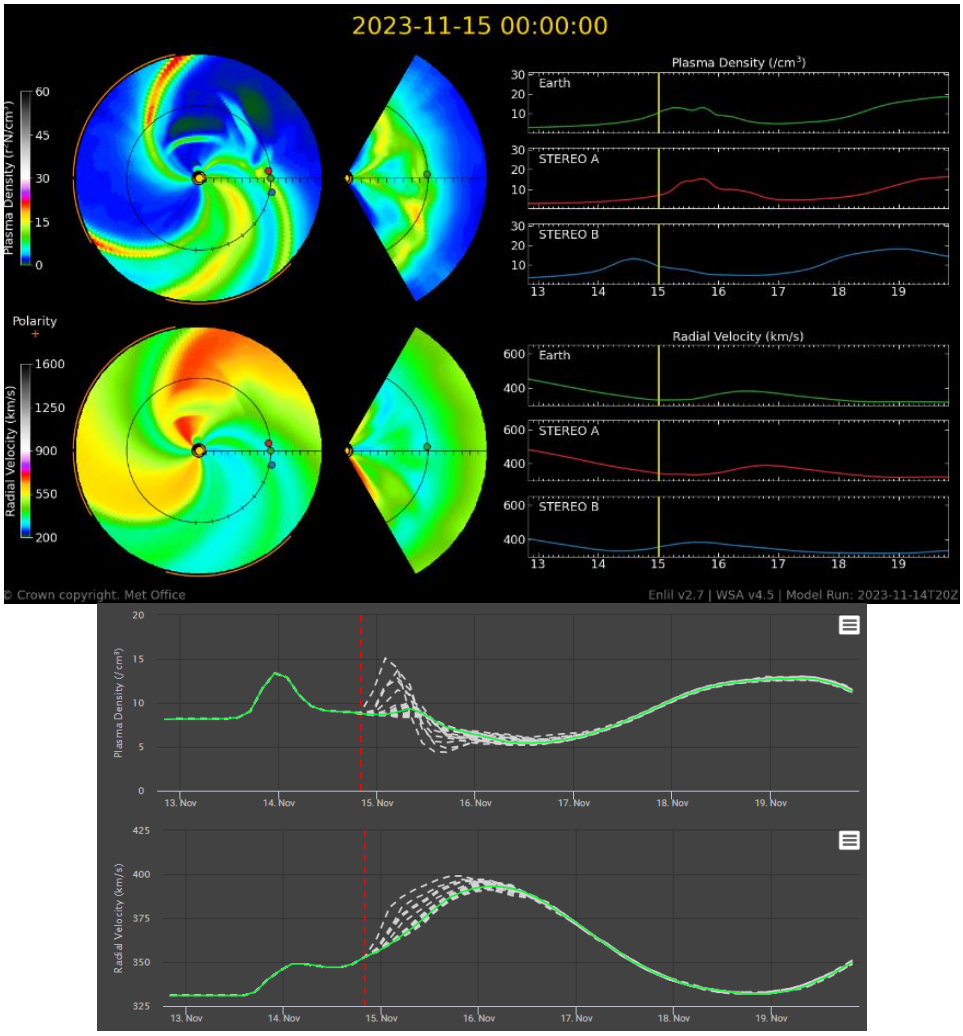
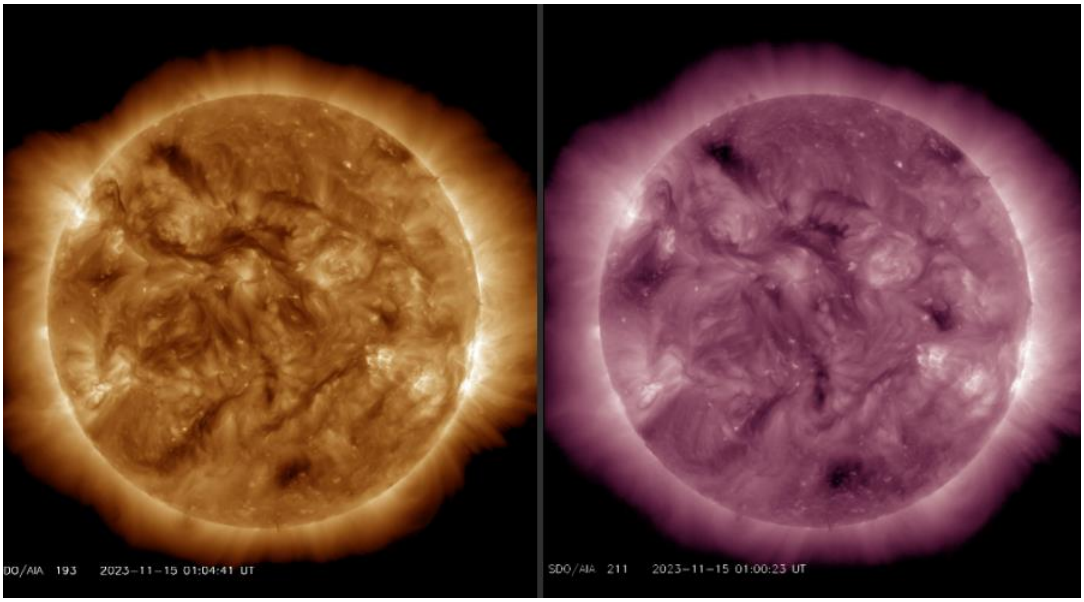


Figure 2b: SDO aia-193 and aia-211 showing small CH70 on west disc.



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Radio Blackouts - X-Ray Flares:

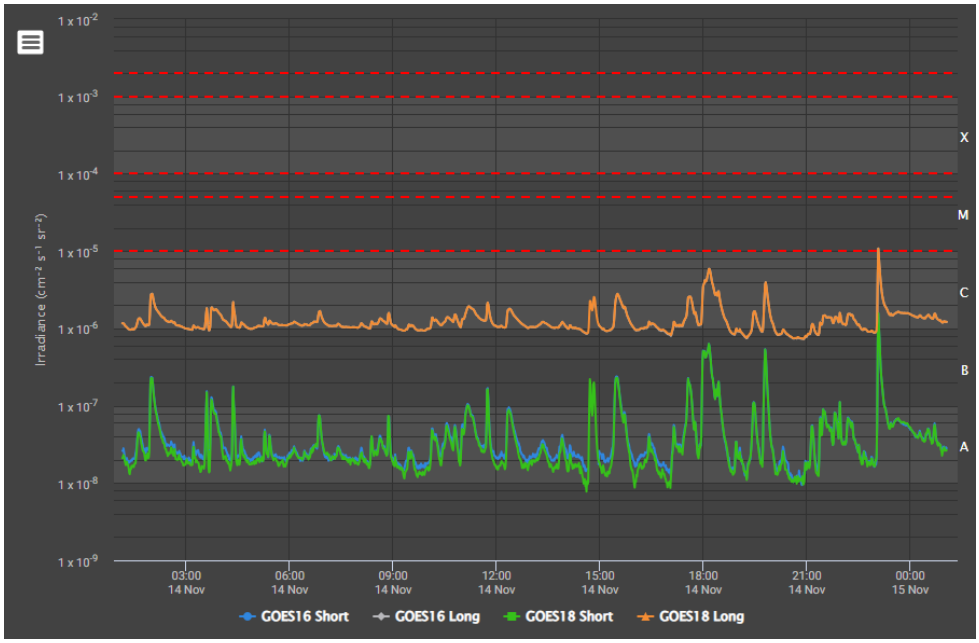
Solar Activity is expected to be Low, with a slight chance of isolated M-flares.

There are four small sunspot regions on the disc. AR3485 was the source of the M1 flare on 14 Nov, however this is increasingly hard to see and will soon move over the southwest horizon day 1 (15 Nov). AR3486 and AR3487 are also in the southwest quadrant. Of these AR3486 is the most notable as the largest region on the disc with ongoing slow flux emergence within its intermediate region, although these spots either quickly fade or combine into the main leader and trailer spot. AR3487 is a smaller and simpler region which is gradually fading and spreading. Both of these will move off the disc by the end of the period.

The only other region on the disc is small AR3488 near the northeast limb. This is a very small region set amongst plage, but there is the potential for more details to become apparent or develop as it moves to a less oblique viewing angle.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	25	20	20	20
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: GOES 16/18 X-ray Flux



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Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 is currently at background levels and expected to persist at this level. There is a very slight chance of flux rising from any significant flares or filament eruptions off the western disc, or just over the western limb, however this is unlikely to reach the S1 Minor Radiation Storm level.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	2	2	1	1
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) at GOES-16 has persisted at background. This is despite recent enhancements which likely increased electron populations at lower orbits (LEO/MEO). These electron populations have the potential to relax back to GEO, with periods of Moderate becoming increasingly likely, perhaps reaching High flux (1000 pfu) at diurnal peak. However there is also the potential for any enhancement from the glancing CME and CH70 on days 1-2 (15-16 Nov) to limit the extent that this occurs. Coupled with a natural decline, the extent of any increase in the observed flux remains low confidence.

The associated 24 hours fluence is expected to persist below the Active level, but with an increasing chance of rising above due to the low confidence with how flux levels will respond to any solar wind enhancements, and also the potential higher flux at LEO AND MEO. This appears to be supported by REFM, which keeps flux at low levels, however this model doesn't take account of any electron flux increase due to the recent solar wind enhancements

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	5	10	20	25
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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